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BC direct radiative forcing constained by AERONET

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To constrain uncertainties for the direct radiative forcing of atmospheric black carbon (BC) ground-based sun-/sky-photometer network AERONET data on aerosol absorption are applied. As mid-visible atmospheric absorption is influenced by large dust sizes, only the absorption of sub-micrometer size aerosol is considered to filter absorption attributed to BC. With assumption to BC size (re=0.13) and composition (RI=1.0, 0.7i) a mid-visible co-single-scattering-albedo (0.64) is determined to permit the conversion of BC absorption into a BC column aerosol optical depth (BC-AOD). The properties can be directly compared to BC-AOD suggested by global modeling. To match AERONET based observations, simulated BC-AOD maps (of any model) are adjusted on a regional monthly basis and applied at input to an off-line radiative transfer code. The simulated direct radiative forcing at the top of the atmosphere (ToA) and under all-sky conditions yields an annual average warming by about +0.30 W/m2 for anthropogenic BC and by about +0.37 W/m2 for total BC. In addition, forcing sensitivity studies are conducted to set the uncertainty range caused by assumptions during the adjustment process for the simulated BC-AOD maps or by simplifications and assumptions in radiative transfer simulations. The overall uncertainty to the ToA all-sky BC forcing is estimated at 50% for anthropogenic aerosol and at 45% for total aerosol. This establishes annual average ToA all-sky radiative forcing ranges of [0.20-0.45] W/m2 for anthropogenic BC and of [0.25-0.55] W/m2 for total BC.